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DREDGED MATERIAL RESEARCH.

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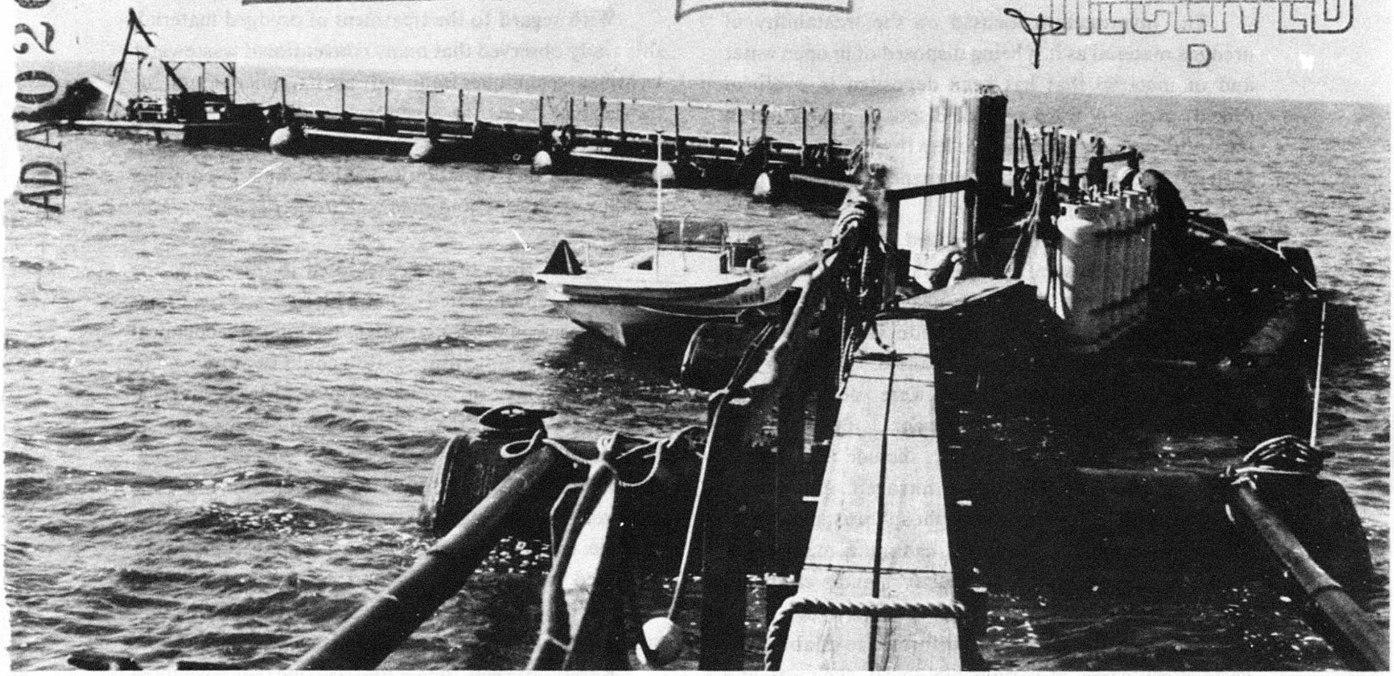


Field demonstration as followup for laboratory-recommended treatment process....A first-step laboratory study (described in the following article) indicated that oxygenation of dredged material slurry enhanced the dissolved oxygen levels in the receiving water column. As a second step, oxygen was injected into a discharge pipe during a full-scale dredging operation as part of the study of oxygenation of dredged material. Initial analyses indicate that, as predicted, the immediate oxygen demand in the water column during the passage of the treated dredged material was within tolerable levels. The photo above shows the float-mounted oxygen-injection system attached to the discharge line of the hydraulic cutterhead dredge *GUTHRIE* during dredging and disposal operations in the Gulf Intracoastal Waterway near Apalachicola, Florida (Mobile District). Both studies are part of the Dredged Material Research Program's (DMRP) Task 6B: Treatment of Contaminated Dredged Material.

TREATABILITY OF DREDGED MATERIAL (LABORATORY STUDY)

The report of research undertaken by the Environmental Engineering Division of the Environmental Effects Laboratory to assess the effectiveness of various methods for the treatment of contaminated dredged material has been published as Technical Report D-76-2. The report was prepared by Thomas K. Moore and Brooks W. Newbry under Task 6B of the Disposal Operations Project (Mr. Charles C. Calhoun, Manager). Besides investigating treatment methods, the study (Work Unit 6B02) sought to examine the adequacy of certain parameters commonly used to describe the pollution potential of dredged material and to recommend applicable treatment schemes.

METHODS

The investigation focused on the treatability of dredged material as it is being disposed of in open water and of material that has been deposited in confined (diked) areas. A third type of disposal, deposition in unconfined areas, accounts for less than 2 percent of all material dredged during maintenance operations and was not included in this study.

To conduct the study, dredged sediment material and water samples were collected at three selected areas: (a) three sites within Mobile Bay near Mobile, Alabama; (b) one site in Maumee Bay at Toledo, Ohio; and (c) one site in Mare Island Strait near Vallejo, California.

Standard analytical tests were performed to determine the chemical and physical characteristics of the dredged material. These tests include analysis for solids, sulfides, total Kjeldahl nitrogen, ammonium nitrogen, nitrate nitrogen, total phosphorus, phosphate phosphorus, mercury, lead, zinc, cadmium, manganese, iron, cation exchange capacity, and grain-size distribution.

Laboratory studies were performed to establish the basic effectiveness of various biological, chemical, and physical processes considered applicable for treatment of contaminated dredged material.

The parameters used to determine the organic nature and biological treatability of dredged material were the biochemical oxygen demand (BOD), chemical oxygen demand (COD), total organic carbon (TOC), and immediate oxygen demand (IOD). The effect of the dredged material on a mixed liquor suspended solids (MLSS) concentration was evaluated. A chemical coagulation analysis was performed to evaluate the amenability of dredged material to chemical treatment. To assess the feasibility of physical treatment, the specific resistance to filtration, the sedimentation or settling characteristics, and the dissolved air flotation were studied. Aeration studies were also performed in the laboratory to determine the nature of the IOD, the total amount of oxygen required by the dredged material, and the effects of aeration on dredged material.

TREATMENT EFFECTIVENESS

Tests on the dredged material samples agree with the results reported by others in indicating that the bulk analysis methods of evaluating the characteristics of dredged material do not adequately assess the environmental effects of dredged material disposal.

With regard to the treatment of dredged material, this study observed that many conventional wastewater treatment techniques frequently are inapplicable and/or impractical prior to open-water disposal: dredged material generally presents a high solids content, a high magnitude and variability of flow, and a complex makeup of physical and chemical properties and organic matter.

For the three areas represented in this study, the analyses demonstrated that biological treatment techniques would be ineffective, but that the chemical coagulation treatment procedure could be employed to reduce turbidity. In studies of physical treatability, it was shown that vacuum filtration can, at least in the laboratory, effectively dewater dredged material. Sedimentation is a useful technique, but the time required for settling out varies and increases as the organic content increases. Direct application of the dissolved air flotation method to dredged material slurries proved to be ineffective in the removal of suspended matter from the samples.

Rapid oxygen depletion is one of the most documented and noticeable effects of dredged material disposal. During laboratory aeration studies it was observed that the depletion of dissolved oxygen (DO) can be appreciably reduced by aerating the slurry. This means that an excess of oxygen, when added to the carrier water, would temporarily meet the oxygen demand and would reduce the IOD to a tolerable level

during the passage of dredged material through the water column. In the disposal site it may not be necessary to supply a quantity of oxygen sufficient to satisfy the entire demand because of the dilution and dispersion occurring in the receiving water.

RECOMMENDED TREATMENT SCHEMES

Three systems demonstrate potential for the treatment of dredged material:

1. In-line aeration, which can greatly reduce or eliminate the depletion of DO in the receiving water body.
2. Confinement in diked areas, which takes advantage of natural sedimentation to separate solid and liquid fractions. The liquid fraction can then be subjected to other procedures in order to remove specific pollutants, fines, and organic matter.
3. Large-scale vacuum filtration, a dewatering process which separates liquid and solid fractions more rapidly than natural sedimentation. The containment area required for this scheme would be smaller than that needed for settling treatment in confined dike areas. The dewatered dredged material can then be handled for sand and gravel reclamation or used as fill material. The liquid fraction can be further treated for pollutant removal.

FOLLOWUP

Treatment processes that the laboratory investigation showed to be effective will be pursued through field studies to determine their feasibility for application in dredging and disposal operation. Three such projects have already been initiated.

In-line aeration was performed in December 1976 by injecting oxygen into the discharge pipe during a full-scale dredging operation. DO content and other physical and chemical properties were monitored in the water column. Preliminary evaluation of the data showed that, as predicted from the laboratory study, the DO oxygen levels were enhanced.

A study is being conducted in which various chemicals are used to treat effluents from a confined dredged material disposal area. The chemicals will be evaluated for effectiveness in removing suspended fine particles of sediment, organic material, and specific pollutants prior to discharge from the disposal area.

The feasibility of using vacuum filtration as a means of dewatering dredged material as it exists from the discharge pipe is under evaluation. The technique has a two-fold purpose in that it provides a rapid means of dewatering and serves a primary treatment step that makes the effluent more amenable to standard treatment processes.

RUC DEMONSTRATED FOR CHARLESTON DISTRICT

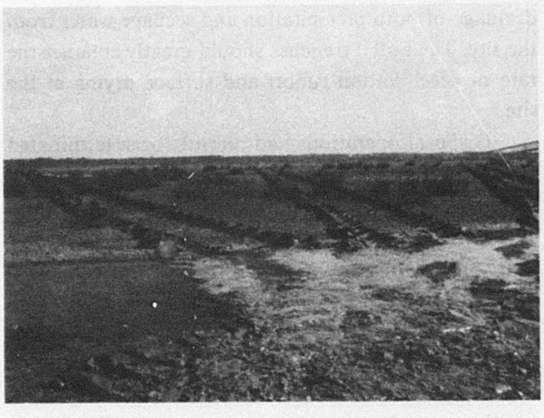
Trenching with a RUC (Riverine Utility Craft) was demonstrated in dredged material disposal areas adjacent to Charleston Harbor during the week of 22 February 1976. The demonstration included operations at three Charleston District disposal areas: Daniel Island, Drum Island, and Morris Island. Photos of the demonstration are shown on the following page.

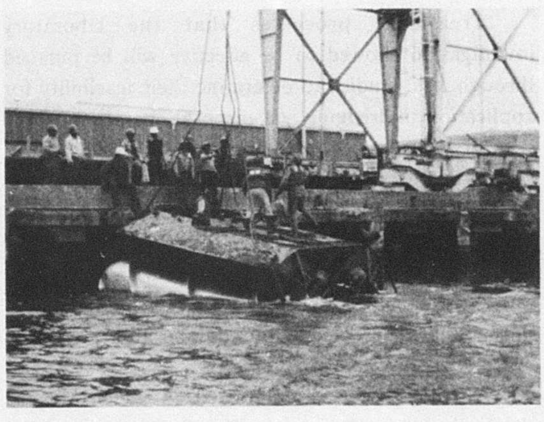
At the Daniel Island disposal area, draglines working form the dikes were being used to develop a perimeter drainage trench to dry dredged material slurry into suitable borrow for raising the dikes. The RUC was used to assist in deepening perimeter trenches and in making interior trenches to channel both seepage water and surface runoff to the perimeter dragline ditches, to obtain more rapid drying of the disposal site interior.

The RUC was employed at the Drum Island disposal area to make finger-pattern radial drainage trenches from each of the three outlet weirs to the approximate center of the disposal site, allowing drainage of both precipitation and seepage water from the site. The radial trenches should greatly enhance the rate of precipitation runoff and surface drying at the site.

Disposal operations had recently been terminated at Morris Island and the RUC was used to cut through high spots and allow both ponded rain water and decanting water to exit more easily from perimeter weirs, thus increasing the rate of surface crust formation.

The RUC produced trenches up to 24 in. in depth in the various soil and crust conditions encountered in the three disposal areas. In addition, the performance of trenching implements towed behind the RUC was evaluated. The trials gave much valuable information concerning the work capability of the RUC and its ability to operate satisfactorily in different disposal area environments. The Charleston District was satisfied with the trenching operations carried out by the RUC and will monitor the effectiveness of the RUC-





1. **Braxton Kyzer inspects surface-drying crust in the Daniel Island disposal area.**
2. **WES technicians measure thickness and cone penetration index of surface crust at the Daniel Island disposal area. Data will be correlated to RUC trench depth for evaluation of vehicle trenching capability.**
3. **RUC trenches 18 to 24 in. deep at the Drum Island disposal site should help surface drainage and drying.**
4. **Radial trenches from the outlet weirs to the center of the disposal area should improve drainage over the entire Drum Island disposal area.**
5. **End of the demonstration, as the crew readies the RUC for loading on its transport.**

developed trenches over the next few months.

Evaluation of the RUC and other vehicles with and without trenching and digging implements will continue in order to develop equipment that will operate effectively in containment areas where less than a 2-ft crust exists.

Mr. Braxton Kyzer, Chief, Survey and Navigation Branch, was responsible for requesting the RUC demonstration, with the concurrence of Mr. Jack Lesemann, Chief, Engineering Division. Dr. T. A. Haliburton, DMRP Geotechnical Engineering Consultant, conducted the demonstration. Messrs. C. R. May and D. E. Strong, engineering technicians of the Mobility and Environmental Systems Laboratory, WES, operated the RUC for the DMRP.

Performance data obtained in the Charleston District will augment the considerable data already obtained and still being produced from extensive trials of the RUC in the Mobile District (see October 1975 issue of this newsletter for details). Input from interested parties concerning potential equipment and trenching devices is requested and communications should be addressed either to Dr. Haliburton or Mr. C. C. Calhoun, Jr., Disposal Operations Project Manager.

DREDGING RESEARCH AND REGULATION FEATURED IN ENVIRONMENTAL SCIENCE AND TECHNOLOGY

Aside from an overview of the recent American Society of Civil Engineers-sponsored Specialty Conference on Dredging and Its Environmental Effects (Mobile, Alabama, 26-28 January 1976), the April 1976 issue of *Environmental Science & Technology* (Vol. 10, No. 4) contains two feature articles on matters relating to dredging and dredged material disposal. In an article entitled, "New Federal Regulations for Dredged and Fill Material," Dr. David D. Smith (President of David D. Smith & Associates, San Diego, California) presents an overview of the Section 404 program of Public Law 92-500, stressing the jurisdictional, procedural, and evaluative aspects. The second article is by Dr. G. Fred Lee, PE (Director of the Center for Environmental Studies of the University of Texas at Dallas), and is entitled "Dredged Material Research Problems and Progress." Attention is directed to what is being done by the DMRP and research needs not being covered by this research effort.

NEW DMRP PUBLICATIONS

Brandsma, Maynard G. and Divoky, David J., "Development of Models for Prediction of Short-Term Fate of Dredged Material in the Estuarine Environment," Contract Report D-76-5, May 1976, prepared by Tetra Tech, Inc., for the Environmental Effects Laboratory, U. S. Army Engineer Waterways Experiment Station, Vicksburg, Miss. (Final Report on Work Unit 1B02.)

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Skjei, Stephen S., "Socioeconomic Aspects of Dredged Material Disposal: the Creation of Recreation Land in Urban Areas," Contract Report D-76-6, May 1976, prepared by the Department of Environmental Sciences, University of Virginia, for the Environmental Effects Laboratory, U. S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi. (Final Report on Work Unit 5D01.)

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Blom, B. E., et al., "Effects of Sediment Organic Fractions on the Migration of Various Chemical Constituents During the Disposal of Dredged Material," Contract Report D-76-7, May 1976, prepared by the U. S. Army Cold Regions Research and Engineering Laboratory for the Environmental Effects Laboratory, U. S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi. (Final Report on Work Unit 1C03.)

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Montgomery, Raymond L. and Palermo, Michael R., "First Steps Toward Disposal Area Reuse," Miscellaneous Paper MP D-76-16, April 1976, Environmental Effects Laboratory, U. S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi. (Overview Task Areas 5A and 5C.)

NOTE: Copies of the above reports will be furnished to individual requestors as long as supplies last. Since it is only feasible to print a limited number of copies, requests for single rather than multiple copies by a single office will be appreciated. Please address all requests to the Waterways Experiment Station, ATTN: Ms. D. P. Booth. When supplies are exhausted, copies will be obtainable from the National Technical Information Service, 5205 Port Royal Road, Springfield, VA 22151.

MODELING ESTUARINE DISCHARGED DREDGED MATERIAL

As part of the task to develop techniques for determining the dispersion of discharged dredged material, two numerical models have been evaluated by Tetra Tech, Inc., for the short-term fate of material discharged into an estuary (DMRP Work Unit No. 1B02). One model simulates instantaneous dump and the other follows jet discharge.

The models have the capability of simulating the spatial and temporal dispersion of as many as 12 types of solid fractions and a fluid fraction of dredged material from discharge through short-term dynamic collapse and long-term diffusion, continuing until the solids eventually settle out of the water column. Though complex, the models are not difficult to use; the authors report that a first-time user can run a simple case in a few hours.

CONSIDERATIONS IN ESTUARINE MODELING

The estuarine environment presents a complexity of phenomena that vary in the three spatial dimensions and in time. Compared to the open ocean, the most important difference is the significant tidal-related current variation. Also important are the variations in ambient density that, unlike the ocean, occur temporally and horizontally as well as vertically. In contrast to the ocean model, the estuarine model must consider land boundaries, significant depth variations, and interaction between transport of the discharged material and the natural suspended load.

In addition to considering the diversity of the estuarine environment, the model must also consider the physical characteristics of the dredged material, which may be a composite ranging from slow-settling fines to fast-falling coarse particles and including a solute fraction. Discharge may be a simple bottom dump from a barge or an extended jet discharge from a fixed pipeline or a moving source. Therefore, the model must be able to accommodate great differences in discharge quantity as it varies with barge course and speed, discharge point depth, and initial discharge velocity.

To meet user requirements, a simulation model should be simple to use yet be complex enough to describe a complicated discharge and versatile enough to handle input for a variety of situations at various information levels.

DEVELOPMENT OF THE MODELS

The models simulate the three phases of material behavior after discharge: (a) convective descent, during which the material tends to fall as a cloud or slug; (b) dynamic collapse, occurring when the descending cloud either impacts the bottom or attains the condition where horizontal spreading exceeds vertical descent; and (c) long-term passive dispersion, beginning when cloud transport and spreading is largely determined by ambient currents and turbulence.

Simulation of the first two phases of behavior is based on a model for ocean dumping developed at Tetra Tech, Inc., Pasadena, California, by R. C. Y. Koh and Y. C. Chang in 1973. The third phase follows the approach taken by H. B. Fischer in 1972 in his predictive model of the fate of chemical wastes in an estuary.

The Koh-Chang model, which assumes the current structure to be uniform in the horizontal direction and variable in the vertical, was modified to allow for unsteady currents and current variations in the horizontal. To apply the Fischer scheme, it was necessary to incorporate conditions of vertical resolution of material concentrations, settling behavior, and density gradients.

DESCRIPTIONS OF THE MODELS

Besides a detailed discussion of the mathematical treatment of behavior of dredged material immediately after discharge from a barge or pipeline, the report provides a complete description of the models including the criteria for transition between computational phases, idiosyncrasies of individual routines, computational situations expected to be troublesome, diagnostic parameters, and example solutions. The appendices of the report present user's manuals for both models along with a listing of the FORTRAN code. Block diagrams of the two models are shown in Figures 1 and 2.

Either model may be run once the bathymetric grid and ambient conditions have been defined and may be set to run for a number of hours. The dump discharge model also requires that the discharging vessel be positioned. Both models describe the dredged material

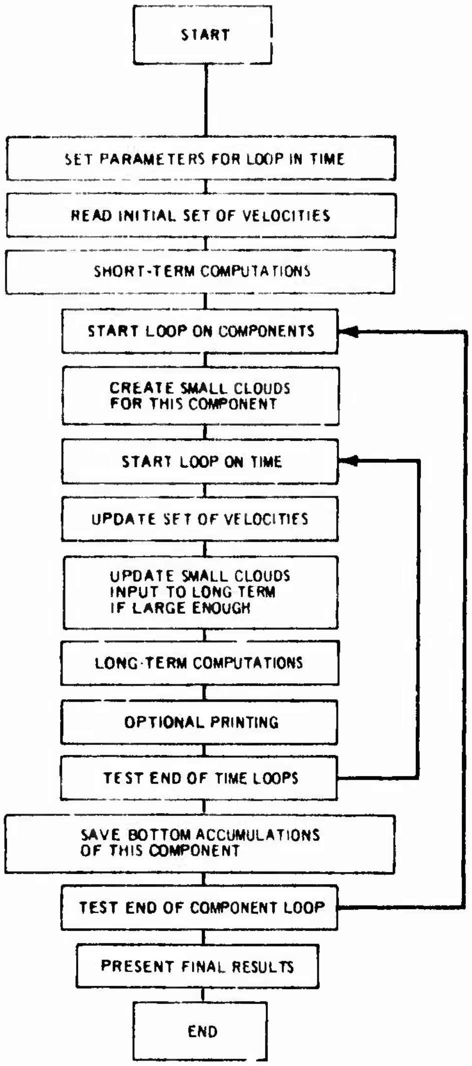


Figure 1. Block diagram of dump discharge model

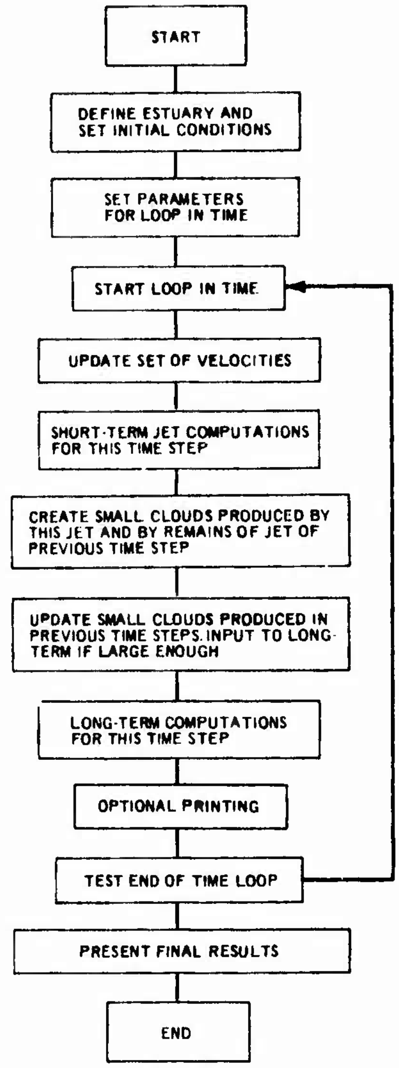


Figure 2. Block diagram of jet discharge model

as an ensemble of particles defined by n-density classes and m-fall velocity classes within each density class. The material is considered to be a well-mixed slurry with no cohesive properties.

For the dump discharge model, the discharge is described by the radius of the initial hemispherical cloud, the depth of the initial cloud centroid, the initial velocity of the cloud, and the initial bulk density of the cloud. For jet discharge, the discharge is described by the volume rate of discharge of the slurry, the initial radius of the jet, the depth of the discharge nozzle, the vertical angle of the discharge nozzle, and the bulk density of the slurry. The model for jet discharge from a moving source assumes the vessel to move counterclockwise and at a constant rate.

The authors emphasize that, while the models have had some testing, they need to be verified with actual field discharge data in order to determine the limits to which they can be confidently applied. It is also stressed that in cases involving complex ambient velocities, the simulation will be extremely dependent on the quality of the velocity data.

The report of the study was prepared by Messrs. Maynard G. Brandsma and David J. Divoky of Tetra Tech, Inc., Pasadena, California, as part of the Environmental Impacts and Criteria Development Project of the DMRP (Dr. Robert M. Engler, Manager). Mr. Barry W. Holliday of the DMRP and Dr. William H. Johnson, WES Hydraulics Laboratory, managed the contract. The report is in press and will be available in the near future.

REDUCING TURBIDITY

Although there are still many questions about the direct and indirect effects of different levels of turbidity on water quality and different aquatic organisms, turbidity generated by dredging and disposal operations can be aesthetically displeasing. Regardless of the ecological effects associated with turbidity, high levels of turbidity generated by both dredging and disposal operations must be controlled where such control measures are deemed necessary.

The first of a series of reports for studies conducted under Task 6C, Turbidity Prediction and Control Research, has been completed. The research was conducted by John Huston, Inc., of Corpus Christi, Texas, as DMRP Work Unit No. 6C03. The report of the study, "Techniques for Reducing Turbidity Associated with Present Dredging Procedures and Operations," concerns operational techniques that could be used with existing dredging equipment and the proper application of existing technology and equipment to reduce the amount of turbidity generated by a dredging operation while maintaining acceptable dredging efficiency. The techniques are evaluated as to their turbidity reduction potential, cost, effect on production, and ease of implementation.

INVESTIGATIVE PROCEDURE

To conduct the study, inquiries were sent to hundreds of people associated with the dredging industry and an extensive review of the literature was made. In addition, a low-level field effort was undertaken to determine the relative magnitude of turbidity generated by a cutter operating at different speeds and at different depths for comparison with the turbidity levels at the same depths in an area unaffected by the dredging operation.

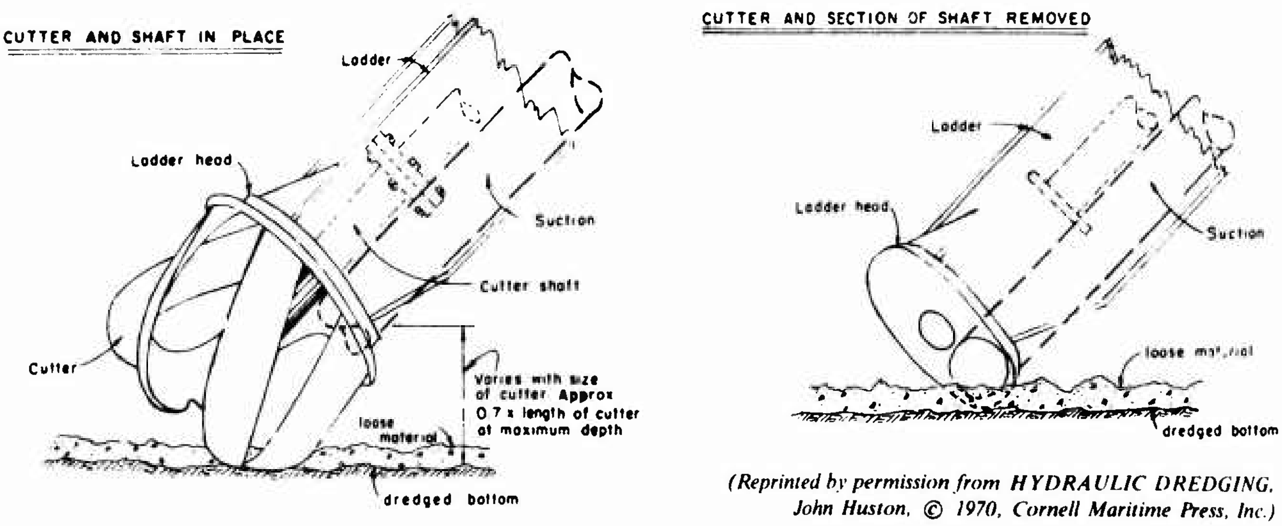
GUIDELINES

Normally, dredge-induced turbidity is found only in the immediate vicinity of the dredge and unless the operation is careless, the levels of turbidity generated are not high. However, most contractors do not take precautions to control turbidity unless forced to and most methods prescribed for reducing and/or controlling turbidity are neither economically nor practically effective.

In general, the dredging procedures that produce efficient and economical dredge operation are generally the best methods for reducing turbidity. The report recommends the following as guidelines for reducing turbidity generated during dredging.

Cutter and Suction

Overcutting can be avoided by using properly designed cutters that remove only what is required and supply it all to the suction. The cutter should not be buried unless all the material will be picked up by the suction. The cutter should be turned as slowly as possible; usually, slower speeds are more economical and create less turbidity. Removing the cutter whenever possible allows the suction to be placed closer to the material (Figure 1). This reduces the amount of turbidity because the suction's pickup capability is



(Reprinted by permission from HYDRAULIC DREDGING, John Huston, © 1970, Cornell Maritime Press, Inc.)

Figure 1. Effect on suction with cutter removed

increased and there is less disturbance of the material.

A rotating suction assembly should be used whenever possible as it permits use of smaller cutters that create less material disturbance. Jets and ladder-mounted pumps, particularly during deep dredging, overcome the effects of suction-line head losses. A jet injects a high-velocity stream of water into the suction; this reduces turbidity by enabling a higher suction velocity to be obtained.

Ladder and Hull

The ladder should be chosen to be appropriate to the dredging depth because an overly long ladder disturbs material not available to the suction.

The hull should also be the proper size for the job; generally the smallest dredge that can do the work should be selected. Hulls that are too wide, long, or deep create turbidity by hitting the sides and bottom of the cut or by causing water turbulence and so resuspending loose bottom material.

Tenders and Pipelines

A significant amount of turbidity can be prevented by using properly sized tenders and by shutting down the engines during idling periods. Pipeline connections should be tight to prevent leakage and lines should be rotated to prevent wear.

Operational Techniques

The swing speed of the dredge and the distance the dredge steps should never be greater than that required to provide the material to the cutter and the suction. Where possible, dredge upstream to maximize the dispersion of any suspended solids and reduce the visibility of any turbidity plume.

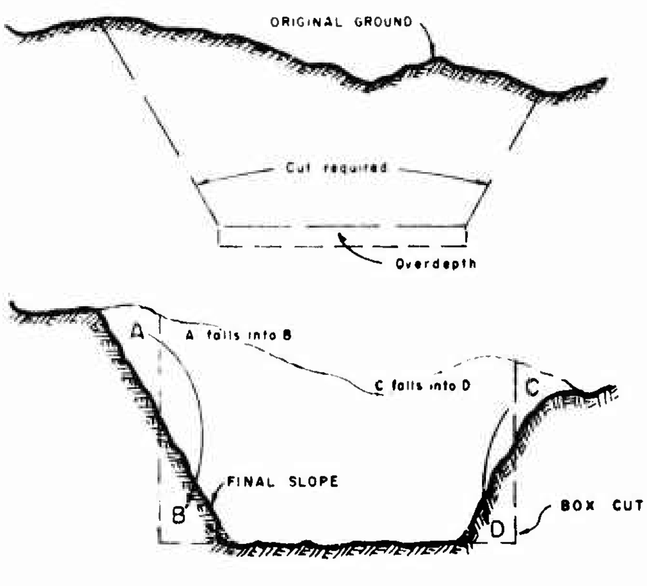
Side-slope cutting is an example of precision dredging to reduce turbidity by reducing the amount of caving material (Figure 2). This technique involves a series of small box cuts rather than one large box cut.

CONCLUSIONS

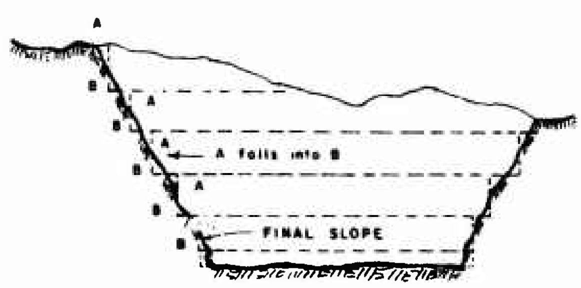
The guidelines presented in this study are not revolutionary and will not eliminate turbidity in the vicinity of a dredging operation. However, the report does represent a synthesis of information on possible techniques for reducing turbidity. The report indicates that, in general, if dredging procedures are conducted with care and if equipment is properly used and maintained, then turbidity will be minimized.

In addition to the guidelines, the report recommends that a continuing school or short courses be established for training dredge personnel and inspectors.

The report of the study was prepared by John W. Huston and William C. Huston of John Huston, Inc. Dr. William D. Barnard managed the contract within the Disposal Operations Project (Mr. Charles C. Calhoun, Jr., Manager). The report is being prepared for publication and should be available in July.



THE BOX CUT



STEPPING THE SLOPE

Figure 2. Side-slope cutting

NEW LITERATURE

DeCoursey, P. J. and Vernberg, W. B., "The Effect of Dredging in a Polluted Estuary on the Physiology of Larval Zooplankton," *Water Research*, Vol 9, No. 2, Feb 1975, pp 149-154.

The effect of water samples from three dredging locations in Charleston Harbor and its tributaries upon the physiology of larval or juvenile zooplankton was determined. The samples for each dredging location included the dredging site, 200 yd downstream, and the weir of the diked disposal area. The effect of the water samples upon survival, metabolism, and behavior of larval or juvenile zooplankton was measured. Since salinities varied at the three locations, the assay organisms include juvenile *Daphnia* for Location I, newly hatched *Paleomonetes* for Location II, and larval *Polydora* for Location III. Weir water proved most toxic; the sample from 200 yd downstream was intermediate in effect. Least toxicity was observed in water from the dredging site.

Garbisch, E. W., et al., "Salt Marsh Establishment and Development," Technical Memorandum No. 52, Jun 1975, U. S. Army Coastal Engineering Research Center, CE, Fort Belvoir, Virginia.

The establishment and development of seedling transplants for shoreline erosion abatement are reported for *Spartina alterniflora* within the intertidal zones and for *Spartina patens*, *Spartina cynosuroides*, *Distichlis spicata*, and *Ammophila breviligulata* within the supratidal zones, of a dredged-material site and three sandy shore sites in the mid-Chesapeake Bay region.

(NOTE: Copies of report are available from the National Technical Information Service, ATTN: Operations Division, 5285 Port Royal Rd., Springfield, VA 22151.)

Limoges, L. D., *The Ecological and Economic Impact of Dredge and Fill on Tampa Bay, Florida*. Ph. D. dissertation, 1975, The University of Florida, Gainesville.

It was the primary objective of this research to complete a comprehensive environmental and economic assessment of Tampa Bay in association with the physical and cultural interrelationships that occur when an estuary has been modified by dredge and fill activities. The procedures encompassed a historical study which examined the coastal modifications accomplished during the past 85 years as well as a discussion of the projected plans for future development. The research included a study of the geographical, geomorphological, biological, and chemical elements which comprise the physical setting. Legislation, governmental agencies, and legal restrictions were discussed as they pertained to the regulation of dredge and fill activities. The ecological and economic impacts of these coastal modifications were examined through a series of case studies. These included a historical sketch of the areas studied, the environmental impact, and the beneficial effects of the works undertaken.

In the author's opinion, dredge and fill activities have greatly modified the littoral zone and have produced a general imbalance in the ecosystem. The more serious and detrimental consequences of dredge and fill occurred during the active period of dredging. It was noted that these detrimental environmental conditions were only temporary and generated few long-lasting effects. However, the study emphasized that once coastal areas have been transformed by filling into sites for industrial and residential land use, they can no longer be used as wildlife refuges. On the other hand, some modifications have included the construction of spoil islands which have been utilized successfully as wildlife habitats. It was pointed out that natural processes return these sterile environments into valuable areas of intensive biological activities. It was suggested that planned environmental modifications could produce areas which could yield valuable assets to the ecosystem.

It was further concluded that there are many economic benefits to be gained through dredge and fill activities. Historically, the ports of the Tampa Bay Estuary have been dependent upon the dredging of channels and filling of sites for port facilities. In the future, due to the increased draft of ships and the conditions of the existing channels, additional channel dredging and maintenance will be necessary for the economic prosperity of the Tampa Bay region. However, it was assumed that any future modifications should come under close scrutiny by environmentalists as well as governmental agencies to insure that any planned alterations would cause the least possible ecological disturbance in relationship to the work proposed. In addition, cost-benefit ratios must be closely evaluated in juxtaposition to any predicted adverse long-term environmental consequences. It was concluded that dredge and fill activities were necessary but their careful planning was mandatory. Only by this procedure can coastal zone management delineate locations which would provide areas of preservation, conservation, and development.

Based on the findings of this research, it was recommended that all coastal modifications be thoroughly researched to evaluate the environmental impact and the significance of this impact upon man and wildlife. There is little evidence for the suspension and termination of dredge and fill activities because dredging represents a potentially significant economic gain to various sectors of our society. This is particularly true as applied to the reduction of costs associated with waterborne transportation. Furthermore, dredge and fill often enhances the recreational potential and, in some cases, increases biological production within the Bay. Furthermore, the recommendations included specific guidelines for dredge and fill activities as they pertain to the various classifications of the state's waters.

Author's Abstract

Grimes, D. J., "Release of Sediment-Bound Fecal Coliforms by Dredging," *Applied Microbiology*, Vol 29, No. 1, Jan 1975, pp 109-111.

Fecal coliform (FC) concentrations increased significantly (F test) in the immediate vicinity of a maintenance dredging operation in the Mississippi River near LaCrosse, Wisconsin. Increased counts were attributed to the disturbance and relocation of bottom sediments by dredging and a concomitant release of sediment-bound FC. It was concluded that observed FC densities probably did not indicate a health hazard. The highest count obtained was 200 per 100 ml during the first day of dredging. However, public health implications of this study are clear; maintenance dredging of bottom sediments heavily contaminated with enteric pathogens could produce a temporary health hazard in downstream recreational areas.

(Reprinted with permission of American Society of Microbiology)

Herbich, J. B and Greene, W. S., "Bibliography on Dredging (Third Edition)," Report No. CDS-179, Sep 1975, Center for Dredging Studies, Texas Engineering Experiment Station, Texas A&M University, College Station, Texas.

Available literature pertaining to dredging has been collected and compiled into six categories (dredge pumps, dredgers, dredging methods, environmental effects, hydraulic transport, and ocean mining). Each category is indexed by author, subject, general listing, and key-words.

Raytheon Company and Bionomics - EG&G, "A Study of the Effect of Marine Sediments on the Survival of Selected Commercially Important Fish and Shell Fish of Massachusetts," prepared for Massachusetts Department of Natural Resources, Oct 1974, Portsmouth, Rhode Island, and Wareham, Massachusetts.

Although a serious shortage of sand and gravel currently exists in the Commonwealth of Massachusetts, extensive reserves of these important construction materials are known to be located offshore. Before recovery of the marine deposits can be contemplated, an evaluation of the environmental effects of dredge spoil must be made. This report discusses a laboratory study of the acute effects of short-term exposure to simulated dredge spoil on some commercially valuable finfish and shellfish from Massachusetts waters.

Dredge spoil was simulated by extracting silt and clay-size grains from bottom sediment samples collected in Massachusetts Bay and by adding the processed fines to water to create suspended solids concentrations within a range estimated to approximate potential field conditions. Physical, chemical, and mineralogic analyses indicated that dredge spoil was accurately simulated.

Laboratory tests consisted of 48- and 96-hour acute static bioassays on a total of 12 finfish and shellfish species of significant commercial value to Massachusetts fishermen. Sediment concentrations as high as 83.2 g/l were employed to evaluate toxicity effects. Quahogs, soft shell clams, and Atlantic oysters showed no effects at this concentration which approximates the estimated maximum concentration of dredge spoil fines expected under actual dredging conditions. Winter flounder and lobster were tolerant of dredge spoils at about one-quarter this concentration, showing no observable effect at concentration of about 20 g/l. Yellowtail flounder, coho salmon, red/white hake, and menhaden all showed 50 percent survival at 96 hours to concentrations in the approximate range of 10 to 20 g/l. Bay scallop larvae, quahog larvae, and Atlantic oyster larvae showed no observable effect on development for the first 48 hours at concentrations up to approximately 10 g/l. Bay scallop adults and silversides showed greatest sensitivity to dredge spoil fines, with 50 percent, 96-hour survival values for bay scallops estimated at 1.8 g/l and silversides between 1.2 and 6.8 g/l.

Previous studies are discussed and an annotated bibliography is presented in Section 7. Where possible, results from these studies are compared to present results. Few studies have been done to observe the effects of natural sediments on marine organisms. Those studies using other types of sediment are difficult to relate directly to potential field situations.

It is concluded that those commercially valuable coastal species tested appear tolerant to short-term exposure to levels of sand and gravel dredge spoil which might be generated under field conditions. Until actual levels can be estimated more accurately, predictions of survival of more sensitive species cannot be made. Additional bioassays are recommended to: improve the predictive value of the present study, provide information of sublethal effects of exposure to lower spoil concentrations over longer periods of time, examine short-term effects on other species, and determine the effects of settling of fines on benthic forms, particularly sessile benthic organisms.

Author's Summary

Schroeder, W. L. and Pyles, M. R., "Disposal of Sandy Pipeline Dredge Spoils by End Dumping," American Society of Civil Engineers, National Structural Engineering Convention, Meeting Preprint 2427, Apr 1975, New Orleans, Louisiana.

The study described in this paper was a 2-year effort supported by the Sea Grant program at Oregon State University to determine the immediate fate of sandy dredged material discharged in water by a pipeline dredge. At the outset of the study an analytical model for fate determination was proposed. The assumption inherent in the model was that the trajectory of an individual sand particle in water could be computed

from the vector sum of the particle settling velocity and the forward velocity in the water body. It was further assumed that the forward velocity could be computed by superimposing the ambient velocity of the receiving water upon the velocity profile induced by the dredge pipeline. The pipeline discharge velocity was computed from empirical data developed for round turbulent jets. Investigation of the model was accomplished in two phases. Initially, laboratory studies were conducted in a basin where the parameters of the model could be controlled. This work indicated that the mathematical model proposed was reasonably valid for predicting the average particle size accumulated downstream from a pipeline discharging a sand-water mixture into still water. The method did not appear to be applicable for discharge into a crossflow. Following the laboratory study the experiments were repeated at four field sites. Two of these sites were on the Columbia River along the Oregon-Washington border, one was in the Willamette River at Portland, and one was in the harbor at Crescent City, California. The results obtained at the first three sites confirmed the validity of the laboratory observations and further indicated the acceptability of the analytical method proposed. The results from the Crescent City site were not usable. The dredged material there was cohesive, and did not satisfy the assumption of discrete particle settling inherent in the theory.

NOTE: The DMRP regrets it cannot be a distributing agent for the new items of literature listed in this newsletter. All items presented are available at the time of listing from the publishing or issuing agency and requests for copies should be addressed to them. In many instances, only limited copies are available and the use of Interlibrary Loan or related services is encouraged.

This bulletin is published in accordance with AR 310-2. It has been prepared and distributed as one of the information dissemination functions of the Environmental Effects Laboratory of the Waterways Experiment Station. It is principally intended to be a forum whereby information pertaining to and resulting from the Corps of Engineers' nationwide Dredged Material Research Program (DMRP) can be rapidly and widely disseminated to Corps District and Division offices as well as other Federal agencies, State agencies, universities, research institutes, corporations, and individuals. Contributions of notes, news, reviews, or any other types of information are solicited from all sources and will be considered for publication as long as they are relevant to the theme of the DMRP, i.e., to provide through research definitive information on the environmental impact of dredging and dredged material disposal operations and to develop technically satisfactory, environmentally compatible, and economically feasible dredging and disposal alternatives, including consideration of dredged material as a manageable resource. This bulletin will be issued on an irregular basis as dictated by the quantity and importance of information to be disseminated. Communications are welcomed and should be addressed to the Environmental Effects Laboratory, ATTN: R. T. Saucier, U. S. Army Engineer Waterways Experiment Station, P. O. Box 631, Vicksburg, Miss. 39180, or call AC 601, 636-3111, Ext. 3233.

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